

Acronym: CSI-03

Title: Commercial Generic Bioprocessing Apparatus Science Insert – 03

Principal Investigator(s):

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Butterfly Pavilion, Westminster, CO

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Sponsoring Agency: National Aeronautics and Space Administration (NASA)

Increment(s) Assigned: 18

Brief Research Summary (PAO): Commercial Generic Bioprocessing Apparatus Science Insert - 03 (CSI-03) is the third set of investigations in the CSI program series. The CSI program provides the K-12 community opportunities to utilize the unique microgravity environment of the International Space Station as part of the regular classroom to encourage learning and interest in science, technology, engineering and math. CSI-03 will examine the complete life cycle of the painted lady butterfly and the ability of an orb weaving spider to spin a web, eat and remain healthy in space.

Research Summary:

- Commercial Generic Bioprocessing Apparatus Science Insert – 03 (CSI-03) is the third in the series of CSI, an educational and science program designed to interest students in Science, Technology, Engineering and Math (STEM) by providing the opportunity for students to participate in near real-time research conducted on board the International Space Station (ISS). Each experiment is designed to be easily reproducible in the classroom providing hands-on experience to the students.
- CSI-03 involves two specific investigations:
 - One will examine the complete life cycle of the *Vanessa cardui*, painted lady butterfly, (egg to butterfly). Students will compare how the complete life cycle of the butterfly differs in space, when compared to butterflies on Earth.

- The other experiment will examine the ability of an orb weaving spider to live in space. Students will compare how the spider in space differs in behavior, feeding and web spinning, when compared to the spiders on Earth.
- For both experiments, students will observe the butterflies and spiders on Earth in their classrooms and compare them to imagery from the ISS.

Detailed Research Summary: Commercial Generic Bioprocessing Apparatus Science Insert - 03 (CSI-03) is the third set of investigations in the CSI program series. The CSI program provides the K-12 community opportunities to utilize the unique microgravity environment of the International Space Station as part of the regular classroom to encourage learning and interest in science, technology, engineering and math.

CSI-03 involves two specific investigations, one will examine the complete life cycle of the *Vanessa cardui*, painted lady butterfly. Students will compare how the complete life cycle of the butterfly differs in space, when compared to butterflies used on Earth. The other experiment will examine the ability of an orb weaving spider to live in space. Students will compare how the spider differs in behavior, feeding and web spinning in microgravity when compared to the spiders on Earth.

CSI-03 can be conducted in the classroom in near real-time, or it can be utilized by teachers at any point during the school year after the space flight experiments are completed. Images and data from the space based experiment are downlinked to the BioServe Payload Operations and Control Center (POCC) on a daily basis while the experiment is active. The downlinked visual data once received will be uplinked to the BioEd Online (<http://www.bioedonline.org/>) website. Participating teachers will be provided with a teacher's guide featuring background information, lesson plans, and student activities for conducting the project in their classrooms.

Scientific Objectives:

- Complete one full life cycle of the painted lady butterfly in space.
- Compare life cycle of the painted lady butterfly on Earth to the life cycle in the microgravity environment of space.
- Compare the ability of an orb weaving spider to spin webs and catch food on the ground to its ability to perform the same tasks in the microgravity environment of space.

Education Goals:

- Students will learn about the life cycle of the painted lady butterfly.
- Students will learn about the behavior, web-building, and food-catching abilities of an orb spider.
- Students will learn about microgravity and its implications for scientific research.
- Students will conduct controlled experiments, practice humane animal-handling and experimental procedures, and compare their control experiment results to those obtained in the flight experiment.
- Students will learn about space science research careers.

Project Type: Payload

Images and Captions:



Vanessa cardui, painted Lady Butterfly, similar to the butterflies scheduled for use in the CSI-03 investigation on the ISS. Image courtesy of Jeffrey Pippen (<http://www.duke.edu/~jspippen/butterflies/paintedlady.htm>)

Operations Location: ISS Inflight

Brief Research Operations:

- CSI-03 will launch to the ISS on board a Space Shuttle. Once the Space Shuttle docks with the ISS, the experiments will be transferred to the ISS by the crew for operation. CSI-03 hardware will be automated to activate the experiments. CSI-03 is an automated payload which will require a small amount of crewmember time to initiate and deactivate.
- The spider experiment will be considered activated once the spider is released from its confined holding area within the habitat and the habitat is placed inside Commercial Generic Bioprocessing Apparatus (CGBA). The butterfly habitat will be considered activated once it is placed inside CGBA.
- Visual imaging will be used to collect data from the two experiments as well as monitor the overall progress of each organism.

Operational Requirements: CSI-03 will operate in the CGBA under controlled temperature conditions and will require imaging and data download daily to BioServe's Payload Operations and Control Center.

Operational Protocols: CSI-03 will be transferred from the Space Shuttle to the ISS and placed inside a CGBA for activation. The hardware for the experiment has been automated to allow imagery of the experiments independent of crew. The ISS crew will implement a procedure to activate CSI-03 on orbit. The ISS crew will also manipulate different feeding components of the hardware to allow fresh food or drink to be exposed for the organisms at a set point in the mission. BioServe will be able to monitor all experiments via data and image downlink. The research will be contained inside the spider and butterfly habitats.

Review Cycle Status: PI Reviewed

Category: Observing the Earth and Educational Activities

Sub-Category: Educational Activities

Space Applications: Results from CSI-03 may help scientists more clearly understand how different organisms are affected by the microgravity environment. CSI-03 influences children to continue their education in the science, technology engineering and math areas and pursue related careers.

Earth Applications: CSI-03 provides a unique educational opportunity to encourage and inspire students to pursue careers in the scientific and technical fields by participating in near real-time research activities on the ISS. This will promote education of the next generation of scientists, engineers, astronauts for the space program.

Manifest Status: New

Supporting Organization: Space Operations Mission Directorate (SOMD)

Previous Missions: Space Technology and Research Students (STARS™), a similar investigation was performed on STS-93 and STS-107. CSI-01 was begun on ISS Expedition 14 and completed during ISS Expedition 15. CSI-02 was performed during ISS Expeditions 15 – 17.

Results: N/A

Results Publications: N/A

Related Publications:

Witt P, Scarboro M, Daniels R, Peakall D, Gause R. Spider web-building in outer space: evaluation of records from the Skylab spider experiment. Journal of Arachnology. 1977;4:115-124.

Web Sites:

BioServe Space Technologies
www.colorado.edu/engineering/BioServe

Butterfly Pavillion
<http://butterflies.org/>

Denver Museum of Natural Science
<http://www.dmns.org/main/en/>

BioEd Online
<http://www.bioedonline.org/>

Related Payload(s): CSI-01, CSI-02

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